SOUTH PAHROC/HIKO G-E-M RESOURCES AREA

(GRA NO. NV-22)

TECHNICAL REPORT

(WSA NV 050-0132)

Contract YA-553-RFP2-1054

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Final Report

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EXECUTIVE SUMMARY

The South Pahroc/Hiko Geology-Energy-Minerals (GEM) Resource Area (GRA) includes the following Wilderness Study Area (WSA): NV 050-0132. The GRA is located in west-central Lincoln County, Nevada on the west side of Delamar Valley and just south of U. S. Highway 93.

The GRA includes the South Pahroc Range and a portion of the Hiko Range. Geologically these ranges within the GRA boundary consist of volcanic rocks less than 60 million years old surrounded by alluvium in the adjacent valleys. The volcanics consist predominantly of welded dacite tuffs, rhyolite, and other tuffs and tuff breccias.

There are no known metallic mineral resources in the study area. The only nonmetallic deposit in the study area is perlite which occurs in one of the volcanic units along the east flank of the South Pahroc range. The currently operating Mackie perlite mine is located here. There are no known strategic and critical minerals in the area.

There are no patented claims in the GRA. There is a group of lode claims along the southwestern boundary of the GRA, but outside the WSA and were staked for an unknown commodity. There are abundant placer claims in the vicinity of the perlite which are presumed to be staked for perlite. There are numerous oil and gas leases in the valley portions of the GRA, but no geothermal leases.

The WSA is considered to have a low favorability for metallic mineral resources, geothermal, and oil and gas with a very low confidence level and a low favorability for uranium resources with a low confidence level. The area has very low favorability for thorium with a very low confidence level. For nonmetallic mineral resources the WSA is considered to have a high favorability for perlite with a high confidence level in the vicinity of the Mackie Perlite mine, a moderate favorability for sand and gravel with a moderate confidence level in the alluvium, and a low favorability for nonmetallics in general with a low confidence level for all the volcanic bedrock remaining in the WSA.

Recommendations for additional work includes more detailed mapping and investigation of the unknown claims in the southwestern portion of the GRA.

I. INTRODUCTION

The South Pahroc/Hiko G-E-M Resources Area (GRA No. NV-22) contains approximately 260,000 acres (1,100 sq km) and includes the following Wilderness Study Area (WSA):

WSA Name	WSA Number
South Pahroc/Hiko	NV-050-0132

The GRA is located in Nevada within the Bureau of Land Management's (BLM) Caliente Resource Area, Las Vegas District. Figure 1 is an index map showing the location of the GRA. The area encompassed is near 37°30' north latitude, 115°00' west longitude and includes the following Townships:

T 4 S, R 61,62 E   T 5 S, R 61-63 E   T 6 S, R 61-63 E

The areas of the WSA are on the following U.S. Geological Survey topographic maps:

7.5 minute:

Hiko, SE   Alamo, NE

The nearest town is Alamo which is located approximately two miles southwest of the southwest corner of the GRA along U.S. Highway 93. Access to the area is via U.S. Highway 93 to the north and west. Access within the area is via unimproved dirt roads scattered throughout the GRA and peripheral to the WSA.

Figure 2 outlines the boundaries of the GRA and the WSA on a topographic base at a scale of 1:250,000.

Figure 3 is a geologic map of the GRA and vicinity, also at 1:250,000. At the end of the report, following the Land Classification Maps, is a geologic time scale showing the various geologic eras, periods and epochs by name as they are used in the text, with the corresponding age in years. This is so that the reader who is not familiar with geologic time subdivisions will have a comprehensive reference for the geochronology of events.

This GRA Report is one of fifty-five reports on the Geology-Energy-Minerals potential of Wilderness Study Areas in the Basin and Range Province, prepared for the Bureau of Land Management by the Great Basin GEM Joint Venture.

The principals of the Venture are Arthur Baker III, G. Martin Booth III, and Dennis P. Bryan. The study is principally a literature search supplemented by information provided by claim owners, other individuals with knowledge of some areas, and both specific and general experience of the authors. Brief field verification work was conducted on approximately 25 percent of the WSAs covered by the study.

The WSA in this GRA was not field checked.

One original copy of background data specifically applicable to this GEM Resource Area Report has been provided to the BLM as the GRA File. In the GRA File are items such as letters from or notes on telephone conversations with claim owners in the GRA or the LWSA, plots of areas of Land Classification for Mineral Resources on maps at larger scale than those that accompany this report if such were made, original compilations of mining claim distribution, any copies of journal articles or other documents that were acquired during the research, and other notes as are deemed applicable by the authors.

As a part of the contract that resulted in this report, a background document was also written: Geological Environments of Energy and Mineral Resources. A copy of this document is included in the GRA File to this GRA report. There are some geological environments that are known to be favorable for certain kinds of mineral deposits, while other environments are known to be much less favorable. In many instances conclusions as to the favorability of areas for the accumulation of mineral resources, drawn in these GRA Reports, have been influenced by the geology of the areas, regardless of whether occurrences of valuable minerals are known to be present. This document is provided to give the reader some understanding of at least the most important aspects of geological environments that were in the minds of the authors when they wrote these reports.

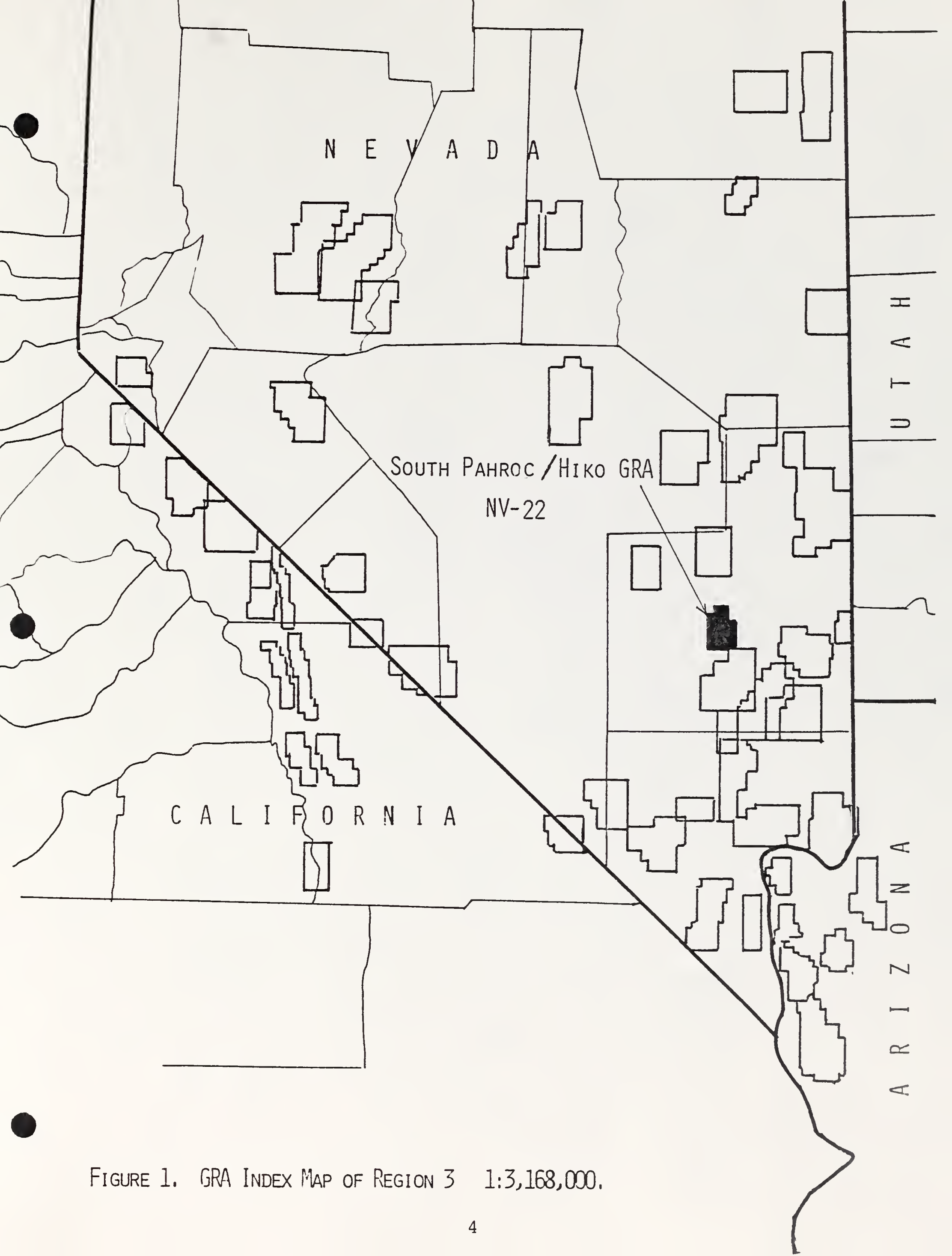
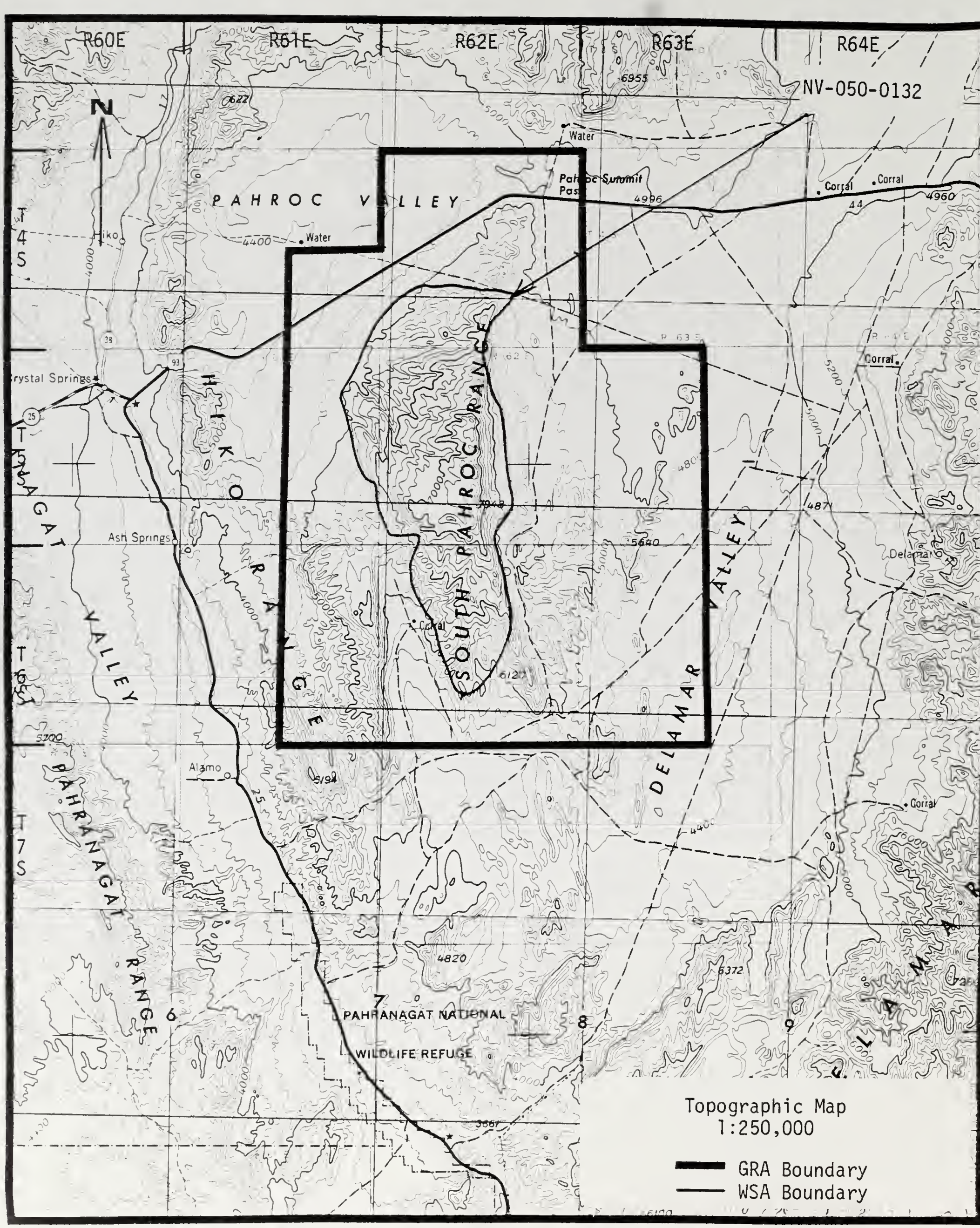


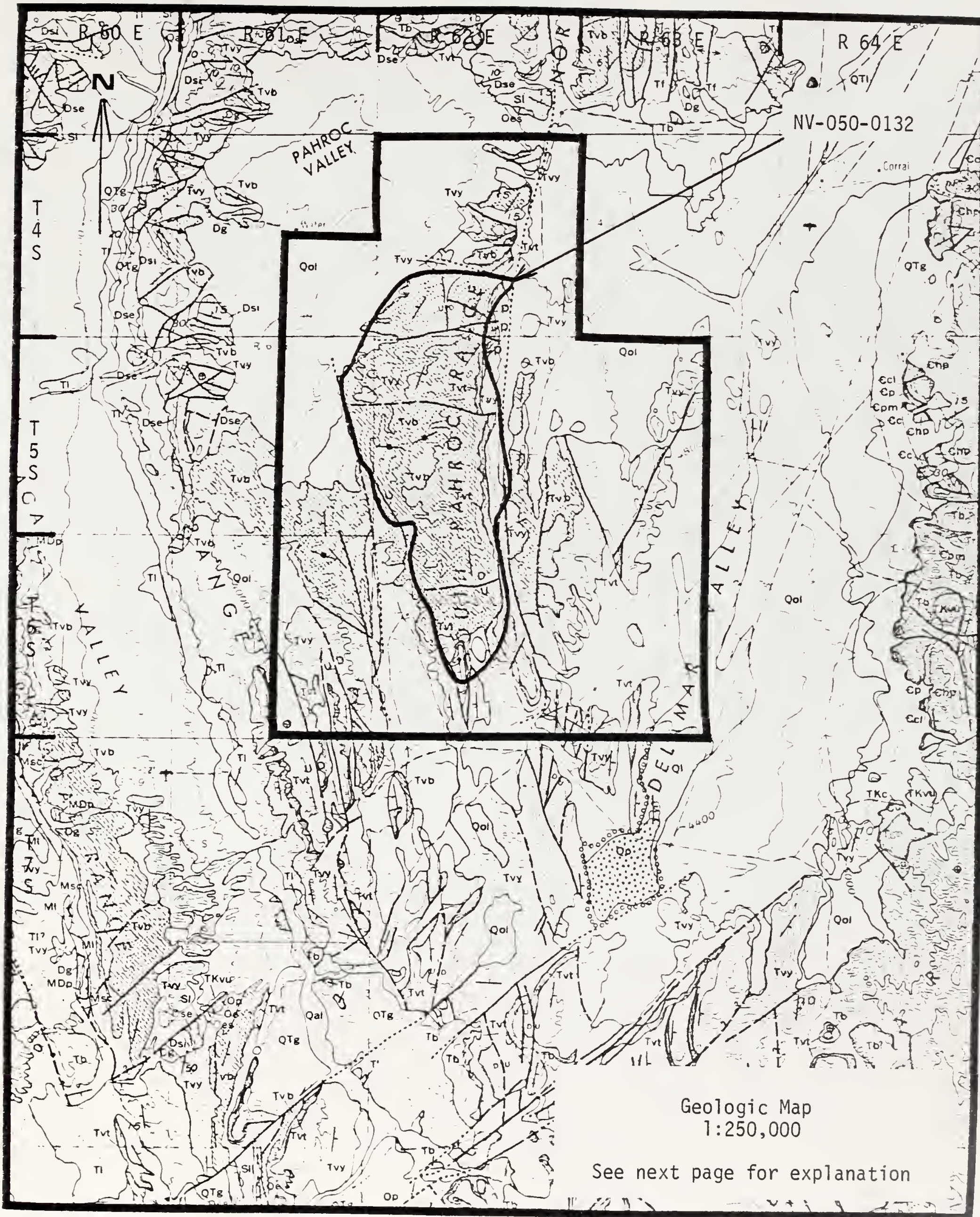
FIGURE 1. GRA INDEX MAP OF REGION 3 1:3,168,000.



Caliente Sheet

South Pahroc / Hiko GRA NV-22

Figure 2



Tschanz and Pampeyan (1970)

South Pahroc/Hiko GRA NV-22

Figure 3

EXPLANATION

TERTIARY(?), QUATERNARY AND QUATERNARY(?)

Recent; Pliocene(?) and Pleistocene(?); Pleistocene(?)

- Qp — Recent playa deposits
- Qs — Dune sand
- Qal — Younger alluvium
- Ql — Younger lake beds
- Qal — Older alluvium
- QTl — Intermediate lake beds
- QTg — Older gravels

UNCONFORMITY

TERTIARY

Pliocene

- Tl — Older lake beds
  Muddy Creek Formation, Panaca Formation, and lake beds in White River Valley
- Tb — Basalt
  Includes some older basalt flows and basalt dikes of several ages

ANGULAR UNCONFORMITY

Eocene(?), Oligocene, Miocene, and Pliocene

Tvy, p, Tva, Tvb, Tvc, Tvd, Tvr, Tvt — Younger volcanic rocks

- Tvy, younger volcanic rocks, undivided, including intravolcanic sedimentary rocks (Ts) and perlite (p)
- Tva, andesite
- Tvb, spheroidal-weathering ignimbrite
- Tvc, rhyolitic unit
- Tvd, biotite dacite
- Tvr, rhyolite complex
- Tvt, tuffs and tuffaceous sediments

Tg, Tr, Tgp, Tgd, Tqm, Td, Tdi, Tvn — Intrusive rocks

- Tg, granite stocks and dikes
- Tr, rhyolite and microgranite dikes
- Tgp, granite porphyry
- Tgd, granodiorite
- Tqm, quartz monzonite or quartz diorite
- Td, diorite
- Tdi, diabase
- Tvn, andesitic volcanic neck

- Tf — Lacustrine limestone
- Tsp — Sheep Pass Formation

Cretaceous(?) or Eocene or Oligocene

- TKvu — Volcanic rocks, undifferentiated

ANGULAR UNCONFORMITY

CRETACEOUS(?) OR TERTIARY

- TKv — Older volcanic rocks
- TKc — Older clastic rocks

UNCONFORMITY

TRIASSIC

Upper Triassic

- Ŧc, Ŧcs — Chinle Formation
  Ŧcs, *Shinarump Member*

UNCONFORMITY (?)

Lower and Middle(?) Triassic

- Ŧm — Moenkopi Formation

EROSIONAL UNCONFORMITY

PERMIAN

Lower Permian

- Pkt — Kaibab Limestone and Toroweap Formation, undivided
- Prb — Red beds

PENNSYLVANIAN

Lower, Middle, and Upper Pennsylvanian

PIPl, Pl, IPs, IPl — Limestone and sandstone

- PIPl, *Permian and Pennsylvanian limestone and sandstone, undivided*
- Pl, *Permian limestone, contains some fossiliferous Pennsylvanian beds in western part of county*
- IPs, *Upper Pennsylvanian sandstone; contains some Permian beds just east of the Limestone Hills*
- IPl, *Pennsylvanian limestone, lower most beds locally contain a very Late Mississippian fauna*

PENNSYLVANIAN

CARBONIFEROUS

MISSISSIPPIAN

Lower, Middle, and Upper Pennsylvanian

PPl | Pl | Ps | Pl

Limestone and sandstone

PPl, Permian and Pennsylvanian limestone and sandstone, undivided
Pl, Permian limestone; contains some fossiliferous Pennsylvanian beds in western part of county
Ps, Upper Pennsylvanian sandstone; contains some Permian beds just east of the Limestone Hills
Pl, Pennsylvanian limestone; lower most beds locally contain a very Late Mississippian fauna

Upper Mississippian

Msc | Msw | Mc

Clastic rocks

Msc, Upper Mississippian clastic rocks, undivided
Msw, Scotty Wash Quartzite
Mc, Chainman Shale

Mm

Monte Cristo Limestone

Lower Mississippian

Ml

Limestone

Includes Joana, Mercury, and Bristol Pass Limestones

LOCAL UNCONFORMITY

DEVONIAN

Upper Devonian

MDp

Pilot Shale

LOCAL UNCONFORMITY

MDu

Mississippian and Devonian rocks, undifferentiated

Middle and Upper Devonian

Dg

Guilmette Formation

Middle Devonian

Dsi

Simonson Dolomite

Du

Devonian rocks, undifferentiated

Lower Devonian

DSu

Devonian and Silurian dolomite, undifferentiated

Dse

Sevy Dolomite

LOCAL UNCONFORMITY

SILURIAN

Middle and Upper Silurian

Sl

Laketown Dolomite

SOu

Silurian and Ordovician dolomite, undifferentiated

ORDOVICIAN

Upper Ordovician

Oes

Ely Springs Dolomite

Middle Ordovician

Oe

Eureka Quartzite

DCu

Devonian to Cambrian limestone and dolomite, undifferentiated

Lower Ordovician

Op

Pogonip Group

CAMBRIAN

Upper Cambrian

Cld

Limestone and dolomite, and Dunderberg Shale, undifferentiated

Middle Cambrian

Chp

Highland Peak Formation

Cu

Cambrian limestone and dolomite, undifferentiated

Middle Cambrian

Cs

Patterson Pass Shale of Kellogg (1959)

Cpc

Pole Canyon Limestone

Cambrian

Cc | Cc

Chisholm Shale, Lyndon Limestone, and Pioche Shale, undivided

Pioche Shale, where mapped separately, shown as marker bed

Cld

Limestone and dolomite, and Dunderberg Shale, undifferentiated

Chp

Highland Peak Formation

Cu

Cambrian limestone and dolomite, undifferentiated

Cs

Patterson Pass Shale of Kellogg (1959)

Cpc

Pole Canyon Limestone

Cc Ccl Cp

Chisholm Shale, Lyndon Limestone, and Pioche Shale, undivided

Pioche Shale, where mapped separately, shown as marker bed

Cpm

Prospect Mountain Quartzite

Includes Wood Canyon Formation and Sterling Quartzite in the Desert Range

pCj

Johnnie Formation

Mapped only in the Desert Range. Equivalent beds may be included in Prospect Mountain Quartzite in the Groom Range

UNCONFORMITY

pCm

Igneous and metamorphic rocks

Upper Cambrian

Middle Cambrian

Lower Cambrian

CAMBRIAN

PRECAMBRIAN

Jasperoid

Highest beach or strand line, or wave-cut terrace

Contact

... where approximately located, dotted where generalized or inferred

Fault, showing dip

... where approximately located, dotted where concealed, query indicates probable or inferred fault ... upthrown side, D, downthrown side. Arrows ... relative horizontal movement

Thrust fault

Dashed where approximately located, dotted where concealed ... where probable or inferred. Saw-teeth on upper plate

Fault breccia

Anticline

Syncline

Overturned syncline

Showing trace of axial plane and direction of plunge of axis. Dashed where approximately located

Strike and dip of beds

Strike and dip of overturned beds

Strike of vertical beds

Horizontal beds

Strike of vertical joints

II. GEOLOGY

The South Pahroc/Hiko GRA lies within the Basin and Range province in central Lincoln County, Nevada. WSA 050-0132 contains much of the north-south-trending South Pahroc Range. The east-central portion of the Hiko Range, which consists of similar rocks, has been included in the GRA.

The South Pahroc Range is a slightly west-dipping tilted block of Tertiary volcanics (see Figure 3). These volcanics have masked the pre-mid-Tertiary structures in the underlying rocks. Northwest-trending Basin and Range normal faults bound both the Hiko and the South Pahroc Ranges. In the Hiko Range steeply-dipping normal faults repeat the west-dipping volcanic sequence at least three times by dropping the east side down. The displacement of these faults is generally only a few hundred feet.

The Mackie perlite mine, about five miles south of U.S. Highway 93 on the east side of the South Pahroc range, is the only property with past production located within the GRA.

Most of the following geological description is taken from the Lincoln County report by Tschanz and Pampeyan, 1970.

1. PHYSIOGRAPHY

The South Pahroc/Hiko GRA lies within the Basin and Range province in central Lincoln County, Nevada. WSA 050-0132 contains much of the north-south-trending South Pahroc Range, a tilted block of Tertiary volcanics. The east-central portion of the Hiko Range, which consists of similar volcanics, has also been included in the GRA.

Northerly-trending Basin and Range normal faults bound both sides of the Hiko and South Pahroc Ranges. Several east-west-trending normal faults which cross-cut the South Pahroc Range terminate at the range front faults.

Elevations along the crest of the South Pahroc Range reach nearly 8,000 feet while elevations to the east in Delamar Valley are as low as 4,400 feet. Drainage of the eastern flank of the South Pahroc Range and terminates at Delamar Lake, a playa. The western side of the range discharges mostly into Pahroc Valley.

2. ROCK UNITS

Rock units within the South Pahroc/Hiko GRA are limited to Oligocene-Miocene volcanics in the ranges and Pleistocene alluvium in the adjacent valleys.

The majority of volcanics cropping out in the study area are spheroidal weathering, pinkish-gray, welded, crystal, dacite(?) tuff. The unit forms cliffs and weathers to form distinctive brown-stained spheroidal outcrop surfaces.

A massive cliff-forming gray rhyolite that weathers brown and contains some black to gray glass and lithic fragments was deposited next.

White, pinkish or orange, lapilli tuffs, and tuff breccias crop out in a thin band along the eastern flank of the South Pahroc Range. The Mackie perlite mine is located within this unit.

A thin strip of undivided volcanics and intravolcanics also crop out along the eastern flank of the range.

3. STRUCTURAL GEOLOGY AND TECTONICS

The predominant type of structure found in the study area is Basin and Range normal faulting. These faults generally strike slightly west of north and dip steeply. Large range front faults bound both the South Pahroc and Hiko Ranges. The Pahroc fault which forms the eastern escarpment of the South Pahroc Range extends for about fifty miles and has a displacement over 1,600 feet.

In the Hiko Range, subparallel normal faults repeat the west-dipping volcanic sequence at least three times by dropping the east side down. The displacement of these faults reportedly is only a few hundred feet (Tshanz, and Pampeyan 1970).

Northeast-trending left-lateral faults cut the volcanic rock at the south end of the Pahroc Range and are a part of the Pahranagat shear system to the south of the GRA (Tschanz and Pampeyan, 1970).

Several well-developed intersecting systems of primarily east-west vertical joints accentuated by erosion occur in large outcrops of spheroidal-weathering ignimbrite.

4. PALEONTOLOGY

Welded and non-welded silicic ash flow tuffs are the dominant lithologies within this GRA, and are not known to have yielded paleontological resources. Areally restricted outcrops of late Miocene lake beds occur outside (west) of the South Pahroc/Hiko GRA boundary but are not indicated as occurring within it, although it is possible that limited unrecorded outcrops may occur. No fossil localities have been recorded from strata within or adjacent to the study area.

5. HISTORICAL GEOLOGY

During the Paleozoic age marine miogeosynclinal carbonate and clastic rocks were deposited throughout the area. Carbonate and clastic sediments deposited during the Early Mesozoic were largely eroded away during the orogenic period that began with uplift in Late Triassic time, and culminated in thrust faulting in Late Jurassic or Cretaceous time.

Subsequent to the Laramide orogeny, volcanism resulted in the outpouring of predominantly ignimbrites during the Oligocene-Miocene. Volcanism was followed by Miocene-Pliocene Basin and Range faulting and subsequent erosion forming much of the present day topography.

III. ENERGY AND MINERAL RESOURCES

A. METALLIC MINERAL RESOURCES

1. Known Mineral Deposits

There are no metallic mineral resources known to exist in the GRA.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

There are no metallic mineral occurrences or prospects known to exist in the GRA.

3. Mining Claims

There are no known patented mining claims in the GRA. There are no unpatented mining claims which are known to have been staked for metallic mineral commodities. There is a group of lode claims paralleling the southwestern boundary of the GRA outside the WSA which was staked in 1972 for an unknown commodity. These claims are in what has been mapped as the spheroidal-weathering ignimbrite.

4. Mineral Deposit Types

Since there are no known metallic mineral resources in the GRA a discussion of the deposit types is not applicable.

5. Mineral Economics

Since there are no metallic mineral resources in the GRA a discussion of the mineral economics is not applicable.

B. NONMETALLIC MINERAL RESOURCES

1. Known Mineral Deposits

There is one known nonmetallic mineral resource in the GRA, the Mackie perlite mine operated by the Delaperlite Partnership Lease (State Inspector of Mines, 1983). The mining claims are under the name of Paramount Perlite Company. The mine is shown on the Nonmetallics Land Classification and Occurrence Map. It is described by Tschanz and Pampeyan (1970) as a large, flat-lying, 20 foot thick perlite flow with obsidian pellets (Apache Tears). The deposit is approximately 8,500 feet long, 800 feet wide, and 20 feet thick. The perlite is part of a sequence of tuffs and tuff breccias that crop out along

the steep eastern scarp of the South Pahroc range. The mine is just outside the eastern boundary of the WSA in section 34 of T 5 S, R 62 E. Cochran (1951) indicates there are 15,460,000 tons of reserves. This is an underground perlite mine which is currently in production, and which is developed by horizontal workings entering the perlite outcrop on the east side of the South Pahroc Range. There has been some open pit production in the past also.

2. Known Prospects, Mineral Occurrences and Mineralized Areas

Additional perlite occurs both north and south of the Mackie perlite mine and are extensions of that same deposit. There are no other known nonmetallic mineral deposits reported in the GRA.

3. Mining Claims, Leases and Material Sites

All the unpatented claims in T 4 and 5 S, R 62 E are placer claims in the vicinity of the Mackie perlite mine and therefore assumed staked for perlite.

There are no known material sites in the WSA but there are some in the GRA along U. S. Highway 93 in the north.

4. Mineral Deposit Types

The perlite in the GRA is a 20-foot thick Tertiary volcanic flow with obsidian pellets.

5. Mineral Economics

The Mackie perlite mine is presently in production on a small-scale basis. The annual tonnages are unknown. It is being mined underground with horizontal access through portals and using rubber-tired equipment. It is believed the material is being marketed into southern California where it is expanded and used in either insulation, lightweight aggregate, or as a filtering medium.

Perlite is a glassy volcanic rock that has the unusual property of expanding to about 20 times its original volume when heated to the proper temperature and almost all of it is used in the expanded form. The largest use of perlite, accounting for more than half of United States consumption, is in construction where it is used as lightweight and insulating aggregate in concrete, alone as an insulator, as an aggregate in fireproof plastic mixes for structural steel, and in other applications. About 15 percent of usage is as a filter aid in many food and

beverage applications. Less than 10 percent is used in agriculture as a soil conditioner, and a great variety of other applications consumes the remainder. The United States uses about 600,000 short tons annually and produces this much plus a little more that is exported. Consumption is forecast to about double by the year 2000, with production keeping up with demand. The price of crude perlite is about $25 per short ton.

C. ENERGY RESOURCES

Uranium and Thorium Resources

1. Known Mineral Deposits

There are no known uranium or thorium deposits in the WSA or GRA.

2. Known prospects, Mineral Occurrences and Mineralized Areas

There are no known uranium or thorium occurrences in the WSA or GRA.

3. Mining Claims, Leases and Material Sites

There are no known uranium or thorium claims or leases in the WSA or GRA.

4. Mineral Deposit Types

A discussion of deposit types is not possible due to the lack of uranium or thorium deposits in the WSA and GRA.

5. Mineral Economics

Uranium and thorium appear to be of little economic value in the GRA due to lack of occurrences of the elements.

Uranium in its enriched form is used primarily as fuel for nuclear reactors, with lesser amounts being used in the manufacture of atomic weapons and materials which are used for medical radiation treatments. Annual western world production of uranium concentrates totaled approximately 57,000 tons in 1981, and the United States was responsible for about 30 percent of this total, making the United States the largest single producer of uranium (American Bureau of Metal Statistics, 1982). The United States ranks second behind Australia in uranium resources based on a production cost of $25/pound or less. United States uranium demand is growing at a much slower rate than was

forecast in the late 1970s, because the number of new reactors scheduled for construction has declined sharply since the accident at the Three Mile Island Nuclear Plant in March, 1979. Current and future supplies were seen to exceed future demand by a significant margin and spot prices of uranium fell from $40/pound to $25/pound from January, 1980 to January, 1981 (Mining Journal, July 24, 1981). At present the outlook for the United States uranium industry is bleak. Low prices and overproduction in the industry have resulted in the closures of numerous uranium mnes and mills and reduced production at properties which have remained in operation. The price of uranium at the end of 1982 was $19.75/pound of concentrate.

Oil and Gas Resources

1. Known Oil and Gas Deposits

There are no known oil and gas deposits in the GRA or the immediate region.

2. Known Prospects, Oil and Gas Occurrences and Petroliferous Areas

There are no known oil seeps, nor have there been any exploratory wells drilled in the GRA. The GRA is situated in the petroliferous, Paleozoic miogeosyncline portion of Nevada and Utah.

3. Oil and Gas Leases

There are numerous oil and gas leases in the valley portions of the GRA, but only five sections are under lease within the western portion of the WSA.

4. Oil and Gas Deposit Types

Oil deposits that have been found and developed, and those that are being explored for in the Basin and Range to date, have been limited to the Upper Paleozoic section of the miogeosyncline and the Tertiary section of the intermontane basins. The source rocks are assumed to be in Paleozoic horizons, such as the Mississippian Chainman Shale, and perhaps also Tertiary section.

The GRA is within or close to the North American Overthrust Belt which has good oil and gas production in Wyoming/Utah, Mexico and Canado (Oil and Gas Jour., May 12, 1980). The Federal leases in Nevada are for rank wildcat acreage, and surficial stratigraphic units do not

necessarily have a direct bearing on possible drilling objectives at depth, considering overthrust structural implications.

Recent seismic surveys (e.g., Seisdata Services, 1981; Geophysical Service Inc., 1981; GeoData, 1981: Index maps in GRA File) indicate, in part, the general area of industry interest. This and certain other data may be purchased, but deep exploratory test data are not readily available. Published maps of the Overthrust Belt in Nevada are very generalized, and are not necessarily in agreement because exploration is at an early stage (Oil and Gas Jour., May 12, 1980; Western Oil Reporter, June, 1980; Keith, 1979: Index maps in GRA File).

5. Oil and Gas Economics

The low level of production from Nevada Basin and Range oil fields, which are remote from existing pipelines, existing refineries and consuming areas, necessitates the trucking of the crude oil to existing refineries in Utah, California and Nevada. Since the discovery of oil in Nevada in 1953, the level of production has fluctuated. Factors which have affected the production from individual wells are: reservoir and oil characteristics; Federal regulations; productivity; environmental constraints; willingness or ability of a refiner to take certain types of oil; and of course, the price to the producer, which is tied to regional, national and international prices.

Geothermal Resources

1. Known Geothermal Deposits

There are three large hot spring areas outside the GRA to the west: Hiko Spring (80°-90°F, 200-5380 gpm discharge) (Locality #1 on the Geothermal Occurrence and Land Classification Map), Crystal Springs (81°-90°F, 2680-9000 gpm) (#2), and Ash Springs Area (88°-97°F, 7630-9000 gpm) (#3), according to Garside and Schilling, 1979. The waters are under 700 ppm total dissolved solids.

2. Known Prospects, Geothermal Occurrences, and Geothermal Areas

There are no other known thermal prospects or occurrences in or near the GRA.

3. Geothermal Leases

There are no leases in the GRA or in the immediate region.

4. Geothermal Deposit Types

Geothermal resources are hot water and/or steam deposits which occur in subsurface reservoirs or at the surface as springs. The temperature of a resource may be about 70°F (or just above average ambient air temperature) to well above 400°F in the Basin and Range province.

The reservoirs may be individual faults, intricate fault-fracture systems, or rock units having intergranular permeability -- or a combination of these. Deep-seated normal faults are believed to be the main conduits for the thermal waters rising from thousands of feet below in the earth's crust.

The higher temperature and larger capacity resources in the Basin and Range are generally hydrothermal convective systems. The lower temperature reservoirs may be individual faults bearing thermal water or lower pressured, permeable rock units fed by faults or fault systems. Reservoirs are present from the surface to over 10,000 feet in depth.

5. Geothermal Economics

Geothermal resources are utilized in the form of hot water or steam normally captured by means of drilling wells to a depth of a few feet to over 10,000 feet in depth. The fluid temperature, sustained flow rate and water chemistry characteristics of a geothermal reservoir determine the depth to which it will be economically feasible to drill and develop each site.

Higher temperature resources (above 350°F) are currently being used to generate electrical power in Utah and California, and in a number of foreign countries. As fuel costs rise and technology improves, the lower temperature limit for power will decrease appreciably -- especially for remote sites.

All thermal waters can be beneficially used in some way, including fish farming (68°F), warm water for year around mining in cold climates (86°F), residential space heating (122°F), greenhouses by space heating (176°F), drying of vegetables (212°F), extraction of salts by evaporation and crystalization (266°F), and drying of diatomaceous earth (338°F). These are only a few examples.

Unlike most mineral commodities remoteness of resource location is not a drawback. Domestic and commercial use of natural thermal springs and shallow wells in the Basin and Range province is a historical fact for over 100 years.

Development and maintenance of a resource for beneficial use may mean no dollars or hundreds of millions of dollars, depending on the resource characteristics, the end use and the intensity or level of use.

D. OTHER GEOLOGIC RESOURCES

No other geological resources are known in the GRA. Coal is not known in the GRA, and there is no known potential for coal.

E. STRATEGIC AND CRITICAL MINERALS AND METALS

A list of strategic and critical minerals and metals provided by the BLM was used as a guideline for the discussion of strategic and critical materials in this report.

The Stockpile Report to the Congress, October 1981 - March 1982, states that the term "strategic and critical materials" refers to materials that would be needed to supply the industrial, military and essential civilian needs of the United States during a national emergency and are not found or produced in the United States in sufficient quantities to meet such need. The report does not define a distinction between strategic and critical minerals.

There are no strategic and critical minerals known to exist in the GRA.

IV. LAND CLASSIFICATION FOR G-E-M RESOURCES POTENTIAL

The only geologic map that covers the GRA in any detail is Tschanz and Pampeyan's, 1970, Lincoln County map at a scale of 1:250,000. Larger scale mapping would better assist in assessment of the mineral potential of the WSA including alteration if present. There is little data on mineral occurrences in the GRA except for the Mackie perlite mine. Overall the quantity of geological data available is low but its confidence level is high. Likewise, the quantity of available information concerning mineral resources is low but the confidence level in the information is high. The lack of information on mineral resources is partly because there has been no other mineral resources recognized in the area other than the perlite deposits.

Land classification areas are numbered starting with the number 1 in each category of resources. Metallic mineral land classification areas have the prefix M, e.g., M1-4D. Uranium and thorium areas have the prefix U. Nonmetallic mineral areas have the prefix N. Oil and gas areas have the prefix OG. Geothermal areas have the prefix G. Sodium and potassium areas have the prefix S. The saleable resources are classified under the nonmetallic mineral resource section. Both the Classification Scheme, numbers 1 through 4, and the Level of Confidence Scheme, letters A, B, C, and D, as supplied by the BLM are included as attachments to this report. These schemes were used as strict guidelines in developing the mineral classification areas used in this report.

Land classifications have been made here only for the areas that encompass segments of the WSA. Where data outside a WSA has been used in establishing a classification area within a WSA, then at least a part of the surrounding area may also be included for clarification. The classified areas are shown on the 1:250,000 mylars or the prints of those that accompany each copy of this report.

In connection with nonmetallic mineral classification, it should be noted that in all instances areas mapped as alluvium are classified as having moderate favorability for sand and gravel, with moderate confidence, since alluvium is by definition sand and gravel. All areas mapped as principally limestone or dolomite have a similar classification since these rocks are usable for cement or lime production. All areas mapped as other rock, if they do not have specific reason for a different classification, are classified as having low favorability, with low confidence, for nonmetallic mineral potential, since any mineral material can at least be used in construction applications.

1. LOCATABLE RESOURCES

a. Metallic Minerals

WSA NV 050-0132

M1-2A. This classification area of low favorability with a very low confidence level includes the entire WSA and covers mostly Tertiary volcanic rocks exposed at the surface. A minor amount of alluvium is also included though in the northwestern portion and along the eastern boundary of the WSA. There is no indication of metallic mineral deposits in the volcanics but the nature of the underlying Paleozoic rocks are unknown. For instance, the old mining district of Delamar is located in a Paleozoic window through similar volcanics approximately twelve miles east of the WSA in the Delamar Mountains. The possibility exists that there is hidden mineralization in the Pre-Tertiary rocks underlying the volcanics hence the 2 classification. The A confidence level is because we have no evidence to support the classification, however.

b. Uranium and Thorium

WSA NV 050-0132

U1-2B. This land classification covers almost all of the WSA and portions of the northern, southwestern, and southeastern parts of the GRA. The area is covered by Tertiary welded tuffs, rhyolite and tuffaceous sediments, and has low favorability, at a low confidence level, for fracture filling uranium deposits in those units. The tuffs are possible sources of uranium which may be mobilized and redeposited in fractures.

The area has very low favorability for thorium at a very low confidence level due to the apparent lack of granitic or pegmatite source rocks in the area.

U2-2B. This land classification covers a small area of the WSA and several areas in the GRA which are covered by Quaternary alluvial deposits. The area has low favorability, with low confidence, for epigenetic sandstone-type deposits. The silicic tuffs and rhyolites exposed in the South Pahroc Range may be a source for uranium which can be leached by ground water and deposited in reduced zones in the alluvium adjacent to the mountains.

The area has very low favorability for thorium deposits at a very low confidence level due to the apparent lack of suitable source rocks.

c. Nonmetallic Minerals

WSA NV 050-0132

N1-4D. This classification area of high favorability with a high confidence level covers the known perlite outcrops, including the presently operating Mackie perlite mine, along the eastern flank of the South Pahroc range.

N2-2B. This classification area includes the remaining volcanic bedrock in the WSA. There are no other reported nonmetallic mineral occurrences in the WSA. Since, however, virtually any material depending on market demands, can be used for construction purposes and any mineral material can become an economic nonmetallic if a use can be developed for its particular chemical or physical properties, this area is considered to have a low favorability of 2 with a low confidence level of B.

N3-3C. This classification includes the small areas of alluvium inside the WSA. This material, sand and gravel, could probably be used in local construction applications, hence the moderate favorability of 3 with a moderate confidence level of C.

2. LEASABLE RESOURCES

a. Oil and Gas

WSA NV 050-0132

OG1-2A. The WSA is underlain by a cover of Tertiary volcanic rocks which probably covers a thick section of Middle to Upper Paleozoic units. Upper Paleozoic rocks are present in outcrop within the eastern margin of the WSA. The low favorability classification is indicative of the presence of a probable thick section of Paleozoic strata which, in other parts of the miogeosyncline, includes both source and reservoir rocks.

The minor leasing in the WSA would seem to indicate industry's low interest as well.

b. Geothermal

WSA NV 050-0132

G1-2A. There is a very low favorability for geothermal resources in the WSA, even though impressive low-temperature resources are present nearby. The deep-seated, normal faults which carry such waters, are present along the entire length of the WSA, which is another positive factor.

c. Sodium and Potassium

WSA NV 050-0132

S1-1C. This classification of no evidence of favorability with a moderate confidence level applies to the entire WSA. There is no indication of favorability for the accumulation of resources of sodium and potassium. There is no classification map for this commodity.

3. SALEABLE RESOURCES

The saleable mineral resources have been discussed above under nonmetallics and include the classification areas N3-3C.

V. RECOMMENDATIONS FOR ADDITIONAL WORK

1. The claims in the southwestern portion of the GRA in the Tertiary volcanic rocks should be investigated further to determine what commodity they were staked for, and if this would affect the classification of similar rocks within the WSA a few miles to the northeast.

2. A more detailed, larger scale, geologic map of the WSA would greatly help in delineating the known perlite resources and any potential alteration in the volcanics as well as possibly identifying as yet unknown resources.

VI. REFERENCES AND SELECTED BIBLIOGRAPHY

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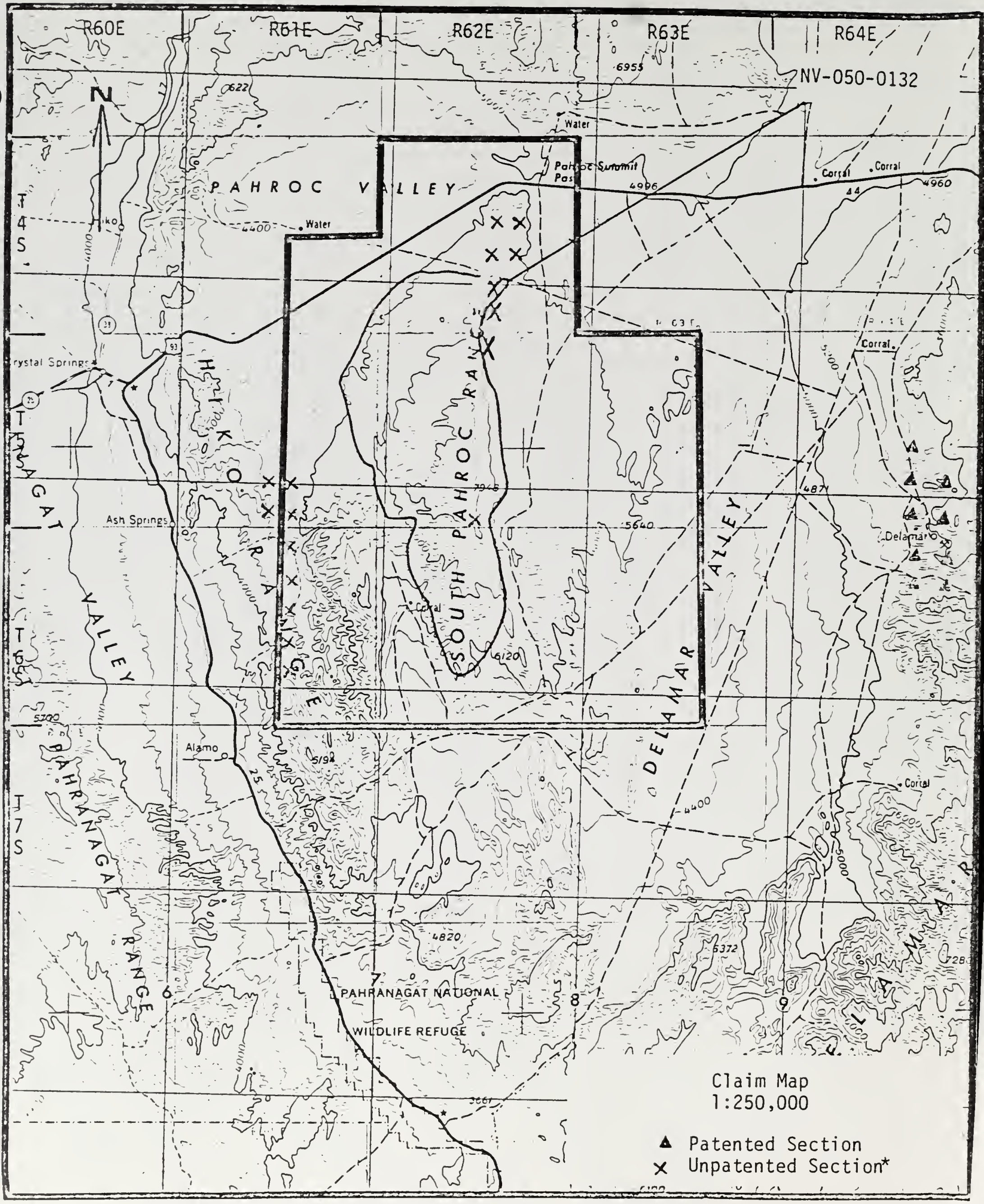
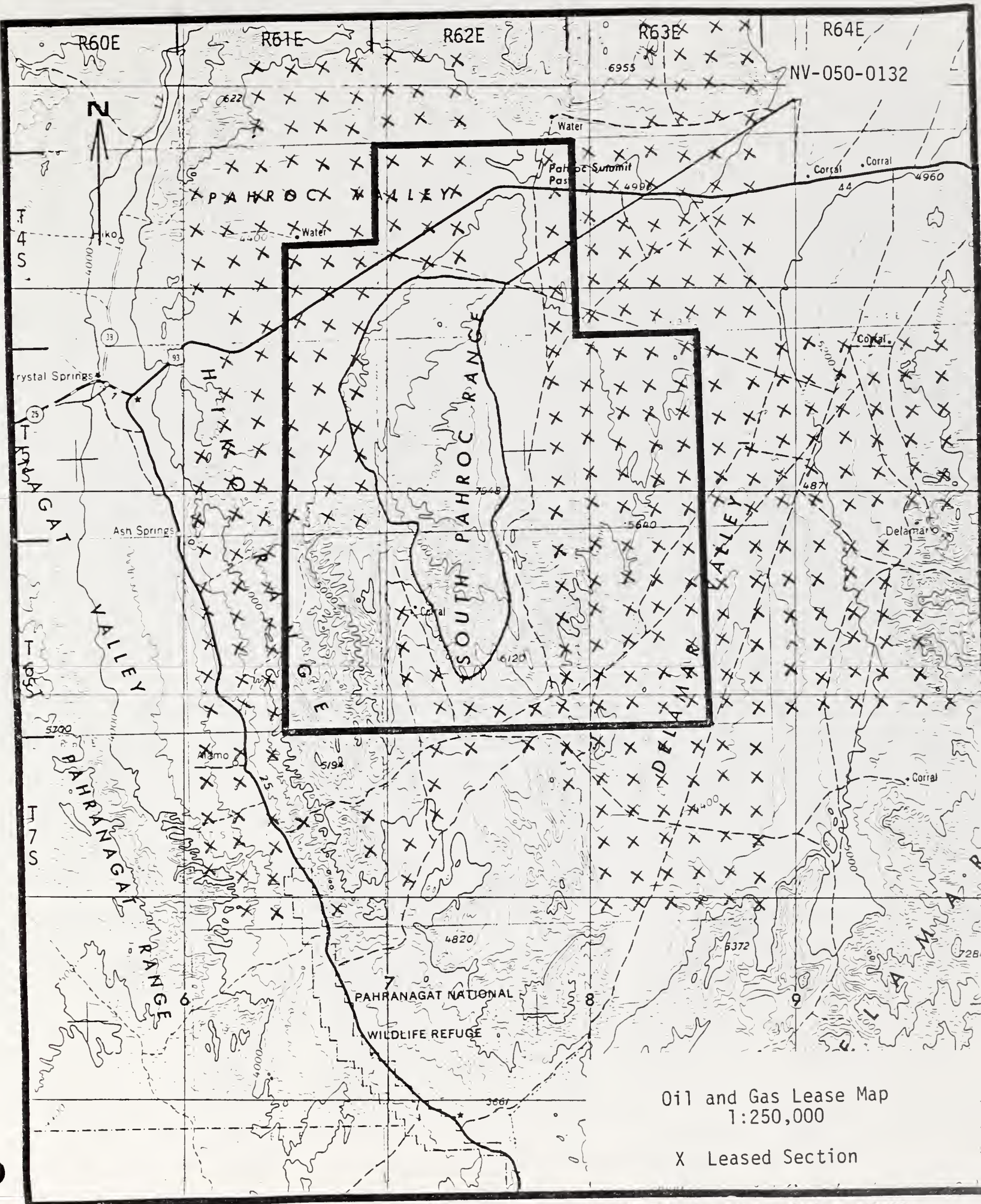


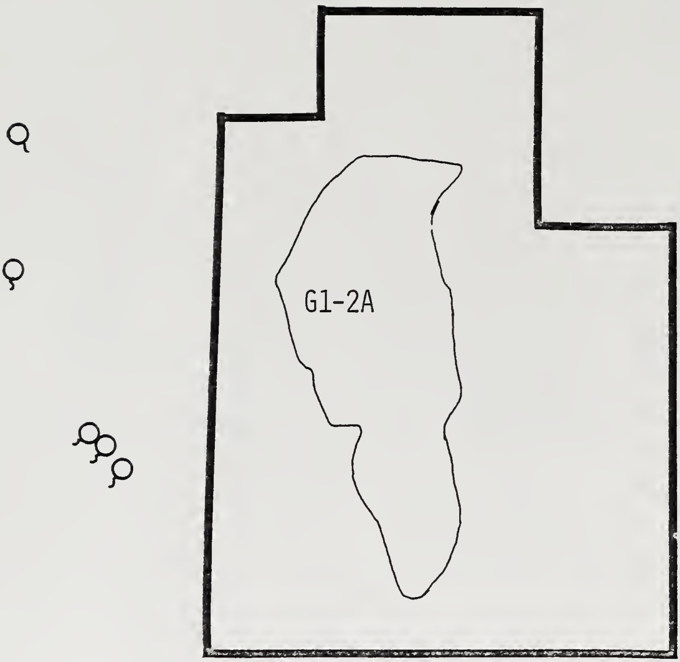
*X denote one or more claims per section

South Pahroc/Hiko GRA NV-22



Oil and Gas Lease Map
1:250,000

X Leased Section



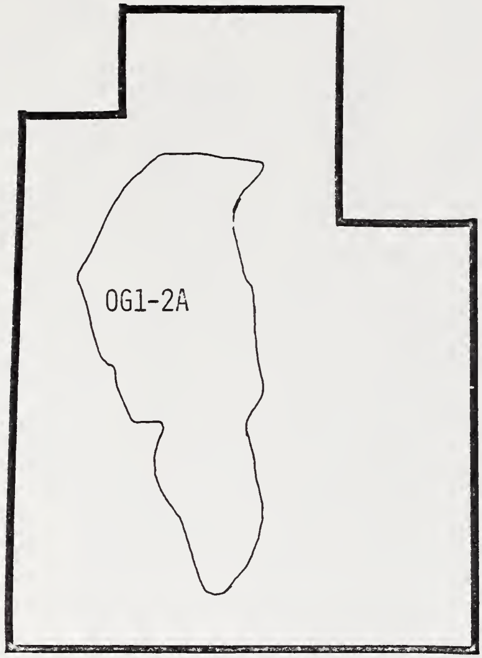
EXPLANATION

Thermal Spring

WSA and Land Classification Boundary

Land Classification - Mineral Occurrence Map/
Geothermal

South Pahroc/ Hiko GRA NV-22
Scale 1:250,000

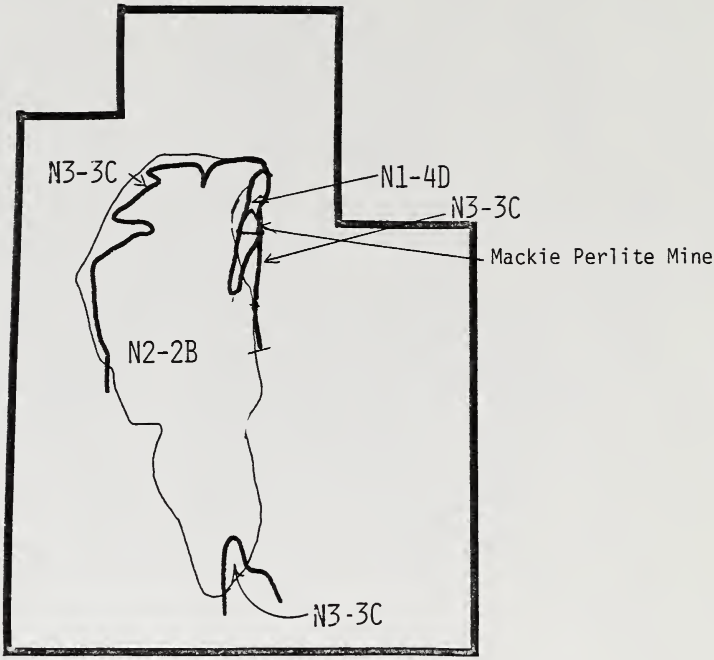


EXPLANATION

—— WSA and Land Classification Boundary

South Pahroc / Hiko GRA NV-22
Scale 1:250,000

Land Classification - Mineral Occurrence Map/Oil and Gas



EXPLANATION

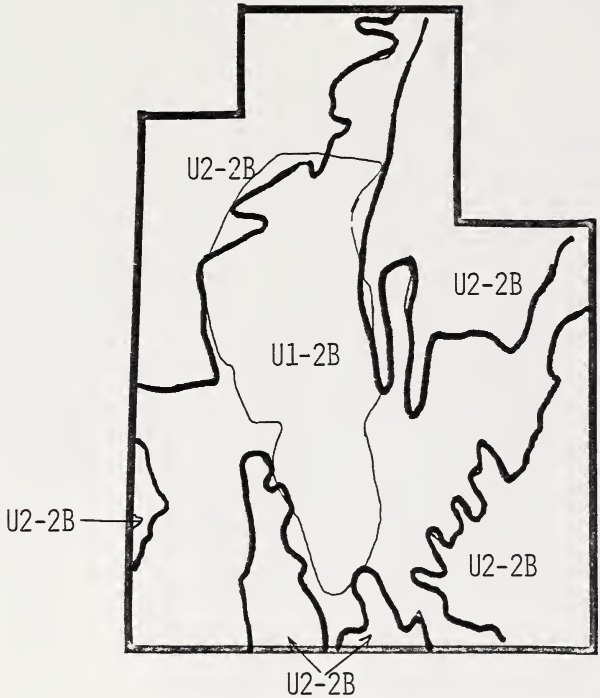
△ Mine, commodity

▬ Land Classification Boundary

— WSA Boundary

Land Classification - Mineral Occurrence Map/
Nonmetallics

South Pahroc/ Hiko GRA NV-22
Scale 1:250,000

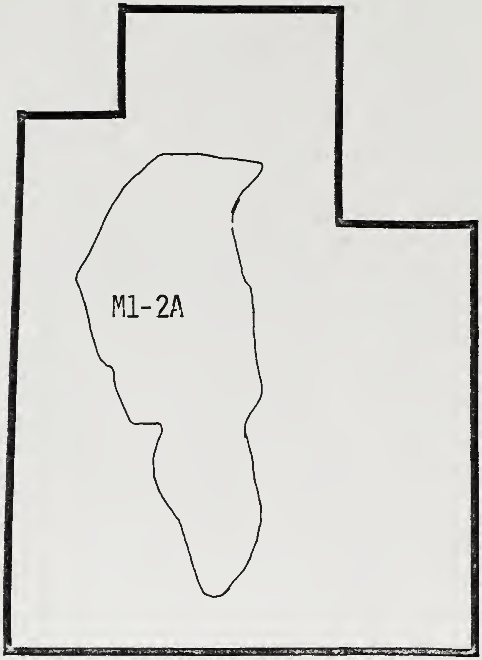


EXPLANATION

Land Classification Boundary

WSA Boundary

Land Classification and Mineral Occurrence Map/Uranium South Pahroc / Hiko GRA NV-22
Scale 1:250,000



EXPLANATION

—— WSA and Land Classification Boundary

Land Classification - Mineral Occurrence Map/
Metallics

South Pahroc, Hiko GRA NV-22
Scale 1:250,000

LEVEL OF CONFIDENCE SCHEME

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVELY MINIMAL TO SUPPORT TO REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

MAJOR STRATIGRAPHIC AND TIME DIVISIONS IN USE BY THE U.S. GEOLOGICAL SURVEY

Erathem or Era	System or Period	Series or Epoch	Estimated ages of time boundaries in millions of years
Cenozoic	Quaternary	Holocene	
		Pleistocene	2-3 [1]
	Tertiary	Pliocene	12 [1]
		Miocene	26 [2]
		Oligocene	37-38
		Eocene	53-54
		Paleocene	65
Mesozoic	Cretaceous [4]	Upper (Late) Lower (Early)	136
	Jurassic	Upper (Late) Middle (Middle) Lower (Early)	190-195
	Triassic	Upper (Late) Middle (Middle) Lower (Early)	225
Paleozoic	Permian [4]	Upper (Late) Lower (Early)	280
	Carboniferous Systems: Pennsylvanian [4]	Upper (Late) Middle (Middle) Lower (Early)	
	Carboniferous Systems: Mississippian [4]	Upper (Late) Lower (Early)	345
	Devonian	Upper (Late) Middle (Middle) Lower (Early)	395
	Silurian [4]	Upper (Late) Middle (Middle) Lower (Early)	430-440
	Ordovician [4]	Upper (Late) Middle (Middle) Lower (Early)	500
	Cambrian [4]	Upper (Late) Middle (Middle) Lower (Early)	570
Precambrian [3]		Informal subdivisions such as upper, middle, and lower, or upper and lower, or younger and older may be used locally.	3,600 + [3]

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[2] Geological Society of London, 1964, The Phanerozoic time-scale; a symposium: Geol. Soc. London, Quart. Jour., v. 120, supp., p. 260-262, for the Miocene through the Cambrian.

[3] Stern, T. W., written commun., 1968, for the Precambrian.

[4] Includes provincial series accepted for use in U.S. Geological Survey reports.

Terms designating time are in parentheses. Informal time terms early, middle, and late may be used for the eras, and for periods where there is no formal subdivision into Early, Middle, and Late, and for epochs. Informal rock terms lower, middle, and upper may be used where there is no formal subdivision of a system or of a series.

GEOLOGIC NAMES COMMITTEE, 1970